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(54) **Method and electric circuit for suppressing radio interference generated by apparatus and installations driven by electric motors**

(57) A method and electric circuit for suppressing radio interference comprises an electric circuit for connecting and starting-up an electric asynchronous motor M_1 used on automatic washing machines or on other appliances.

The inductance of the motor windings L_1 and L_2 is used as part of the noise filtering circuit.

The contacts c_2 for controlling the motor are connected between separate parts of the stator windings L_1 and L_2. The terminals of the motor A_1 and B_1 are connected through a noise filter F_1 to an electric supply. The inductance of the windings L_1 and L_2 contributes to the inductance of the filter F_1 and thus increases the efficiency of the filter in suppressing radio-frequency interference upon start-up of the motor.

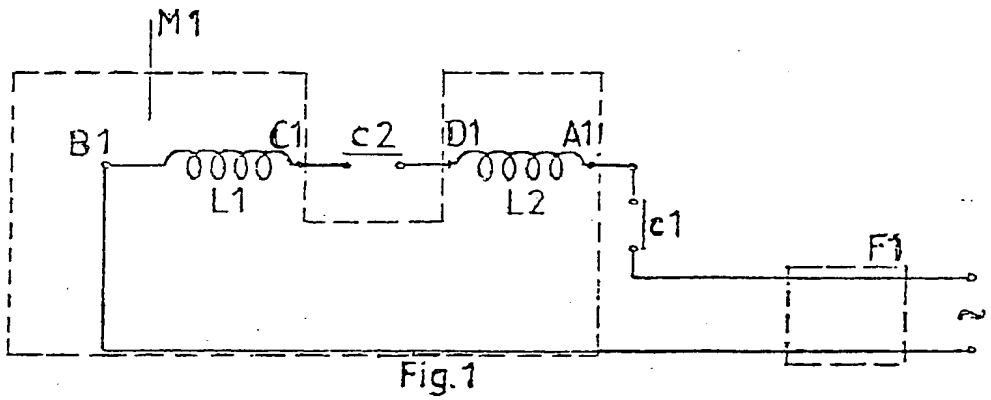

Fig.1

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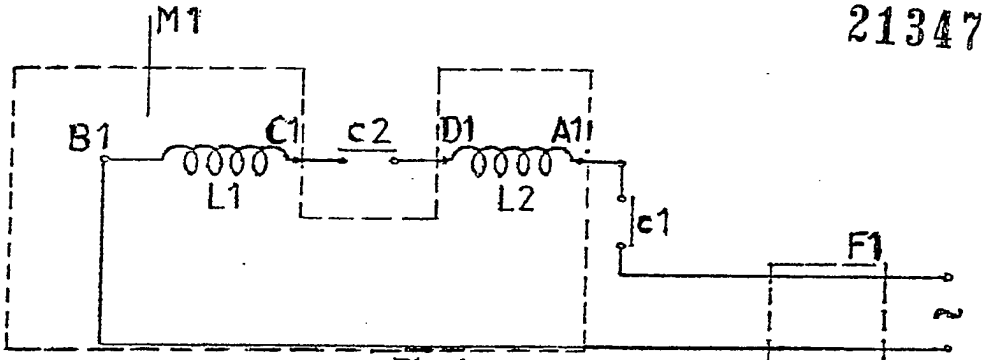

Fig.1

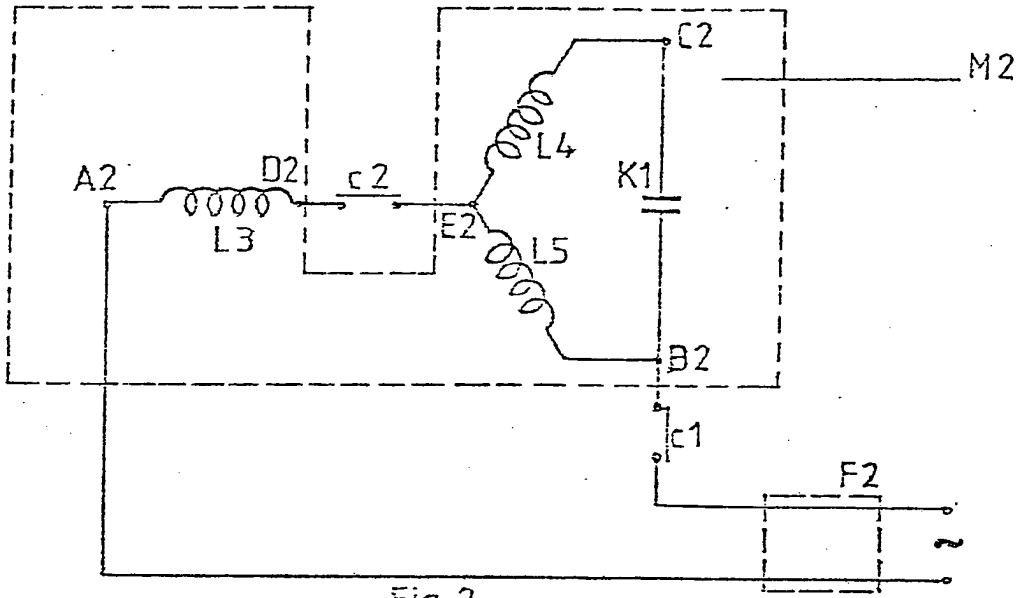

Fig. 2

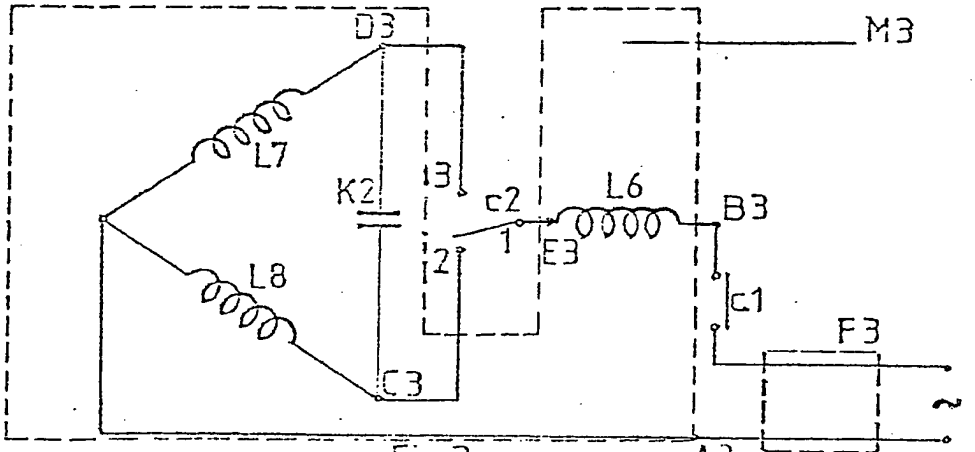

Fig.3

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SPECIFICATION

Method and electric circuit for suppressing radio-interference generated by apparatus and installations driven by electric motors

The invention relates to a method and an electric circuit for suppressing radio interference generated by appliances, for example: washing machines, dishwashers, driven by electric motors.

The use of capacitive or inductive-capacitive filters for suppressing radio-electric interference generated by the switching on and off of electric motors is known.

This method has the following disadvantages:

— in spite of their relative simple construction, capacitive filters are not always sufficiently efficient;

— inductive-capacitive filters are more efficient than capacitive ones, but there are special problems of making inductances, which lead to a higher cost than for the capacitive filters.

These disadvantages are overcome by the method according to the invention.

According to the present invention in a first aspect there is provided a method of suppressing the radio interference generated by an electric appliance or installation, driven by an electric motor, the method including connecting electric contacts which control the motor in circuit between separate stator windings and connecting a noise filter to the motor terminals, so that the inductance of the stator windings takes the place of, or supplements, the inductance of the noise filter.

According to the present invention in a second aspect there is provided an electric circuit for suppressing the radio interference generated by an electric appliance or installation, driven by an electric motor in which electric contacts for controlling the motor are connected in circuit between two distinct parts of the stator windings of the electric motor, the motor windings being connected to electric supply terminals through a noise filter.

Three embodiments of the invention will now be described with reference to the accompanying drawings in which:

—fig. 1 shows an electric circuit, used to connect a shaded-pole motor, in order to suppress radio interference by using the method according to the invention;

—fig. 2 shows an electric circuit, used to connect a permanent-split capacitor motor, in order to suppress radio interference, by using the method according to the invention;

—fig. 3 shows an electric circuit, used to connect reversible permanent-split capacitor motor, in order to suppress radio interference, by using the method according to the invention.

The method used to suppress radio interference generated by electric appliances driven by electric motor, for example washing machines and dishwashers, consists in using the inductance of the stator windings for filtering the disturbing currents generated by the electric contacts of a programmer or other control element of the electric motor.

For this purpose, the stator winding is divided into two distinct parts, whose leads are easily accessible and brought out to the motor terminals.

The contacts of the programmer or of the control element for driving the electric motor intermittently is connected in circuit between the separate groups of windings. The contacts of the programmer or of the control element switches on the stator winding circuit so that the necessary technical parameters are fulfilled by the motor. This interposing of the contacts between the stator windings simultaneously enables the contacts to fulfil their operating functions of connection and disconnection of the motor as the appliance works through its program, and introduces the stator windings with the filter circuit for suppressing interference.

In this way, the windings groups, connected by the contacts, also serve a filtering inductance function, the motor being connected to a supply system by a noise filter.

Thus, the efficiency of the filter damping of the radio interference generated by the programmer or the control element contacts during the repeated connection or disconnection of the motor is increased by the inductances of the two stator windings. The whole assembly (motor-programmer or control element contact-noise filter) works under high frequency conditions, as an inductive-capacitive filter, with high inductance, to which the inductance of the motor windings contributes.

The radio interference suppressing electric circuit of a first embodiment of the invention is illustrated by the drawing of fig. 1. A shaded-pole motor M_1 is controlled by a programmer or other control element and used to drive for washing machines, dishwashers or other electrical appliances.

The stator winding of the motor M_1 consist of two windings L_1 and L_2, whose leads A_1, B_1, C_1 and D_1 are easily accessible and brought out to terminals.

The leads A_1 and B_1 of the windings L_1 and L_2 are connected to the supply system by means of a contact c_1 and a noise filter F_1. The leads C_1 and D_1 are connected by means of a contact c_2 of the programmer or control element which can be of known design and therefore is not illustrated in the drawing fig. 1.

The contact c_1 is used to connect the motor M_1 to the supply system for the whole programmed duty period.

The contact c_2 operates the motor intermittently, by successively switching on and off the circuit of the electric motor, according to the established program.

By means of the contact c_2 between the two windings L_1 and L_2, the circuit of the stator windings is switched on and, simultaneously, the radio interference generated by this contact are suppressed, as a result of the inductances L_1 and

L_2 contributing to the efficiency of the F_1 noise filter.

The second embodiment of electric circuit is illustrated in the drawing fig. 2 and shows a circuit for a washing machine, a dishwasher or other electric appliances, driven by a permanent-split capacitor motor M_2.

The stator winding of the motor M_2 consists of 3 windings L_3, L_4 and L_5, whose leads are easily accessible and brought out to the terminals A_2, B_2, C_2, D_2 and E_2. The windings L_3 and L_5 form the main phase of the motor, while the winding L_4 forms its auxiliary phase.

The phase shifting element of the auxiliary phase, in this embodiment, a capacitor K_1, is connected between the lead B_2 of the main phase winding L_5 and the lead C_2 of the auxiliary phase winding L_4.

The windings L_4 and L_5 are connected to a common terminal E_2. The leads A_2 and B_2 of the windings L_3 and L_5 are connected to the supply system by means of contact c_1 and a noise filter F_2.

The contacts c_2 of the programmer or control element of the motor M_2, already known and not illustrated, are connected to the terminal D_2 of the winding L_3 and to the common terminal E_2 of the windings L_4 and L_5.

The contacts c_1 provide a connection for the motor M_2 to the power supply, for the whole programmed duty period.

By successively switching on and off, the motor M_2 circuit, the contact c_2 operate the motor intermittently according to the programme.

Because the contacts c_2 are connected between the windings L_3 and the windings L_4 and L_5 the motor performs the proper technical requirements and the radio interference generated by the contacts is suppressed, as a result of the contribution the inductance of these windings L_3, L_4 and L_5 make to the increasing of the F_2 noise filter efficiency.

A third embodiment of the noise suppression electric circuit is illustrated in fig. 3, which shows a circuit for a washing machine, a dishwasher or other electric appliances driven by reversible permanent-split capacitor motor M_3.

The stator winding of the reversible permanent-split capacitor motor M_3 consists of 3 windings L_6, L_7 and L_8, whose leads A_3, B_3, C_3, D_3 and E_3 are easily accessible and brought out to the motor terminals.

The windings L_7 and L_8 are identical and symmetrically shifted to the L_6 winding and one of their leads is connected to a common terminal A_3.

The phase shifting element, in the embodiment, a capacitor K_2, is connected between leads D_3 and C_3 of the symmetical windings L_7 and L_8.

The common lead A_3 of the symmetrical windings L_8 and L_7 and the lead B_3 of the winding L_6 are connected to the supply system by means of a contact c_1 and a noise filter F_3.

The contact c_2 of the programmer or of the motor M_3 control element, already known and not illustrated, is a switching contact. For the motor M_3 to turn in one rotation direction, the contacts c_2 connect the terminal e_3 of the winding L_6 to the terminal D_3, of the symmetrical winding L_7.

For the motor M_3, to turn in the reverse direction, the contacts c_2 connect the terminal E_3 of the winding L_6 to the terminal C_3 of the symmetrical winding L_8.

When the contact c_2 is on the middle position, the motor M_3 is motionless. The contact c_1 provides the motor M_3 connection to the supply system for the whole programmed duty period. By successive switching from terminal C_3 to the terminal D_3 the contact c_2 causes the motor M_3 to turn alternately in opposite directions under repeated reversals condition, with a break between reversals when the contact c_2 is in the middle position. This connection of the contact c_2, between the lead E_3 of the winding L_6 and, successively, the leads c_2 and c_3 of the symmetrical windings L_7 and L_8, ensure the proper switching on of the stator winding circuit and simultaneously the suppression of radio interference generated by these contacts, as a result of the contribution the inductance of these windings L_6, L_7 and L_8 make to the noise filter F_3 efficiency.

This electric circuit including the contact of the programmer or of the motor M_3 control element, the windings L_6, L_7 and L_8 and the noise filter F_3, works under high frequency conditions, as an inductive-capacitive filter, with high inductance, to which the inductance of the motor contributes.

The radio interference generated by the contacts c_2 during the motor M_3 connection and disconnection are damped by the noise suppression circuit according to the invention.

The invention has the following advantages:

— strong damping of the radio interference generated by the programmer's or by another control element's contacts, the circuit working under high frequency conditions, as an inductive-capacitive filter with inductance, to which the inductance of the driving asynchronous motor windings contributes;
— the noise filter efficiency is increased;
— the noise filter dimensions may be decreased;
— the cost of eliminating interference may be decreased.

Claims

1. Method of suppressing the radio interference generated by an electric appliance or installation, driven by an electric motor, the method including connecting electric contacts which control the motor in circuit between separate stator windings and connecting a noise filter to the motor terminals, so that the inductance of the stator windings takes the place of, or supplements, the inductance of the noise filter.

2. A method according to Claim 1, in which the said contacts are the contacts of the programmer or control circuit for the appliance or installation.

3. An electric circuit for suppressing the radio

interference generated by an electric appliance or installation, driven by an electric motor in which electric contact for controlling the motor are connected in circuit between two distinct parts of the stator windings of the electric motor, the motor windings being connected to electric supply terminals through a noise filter.

4. A circuit according to Claim 3 for driving a shaded-pole motor, in which the electric contacts of a programmer for operating the motor intermittently according to the program are connected to the middle terminals of first and second separated windings of the stator windings, the second terminals of the first winding being connected to one terminal of the filter while the second terminal of the other windings is connected through contacts to the other terminal of the filter which, in turn, is connected to electric supply terminals.

5. A circuit according to Claim 3 for driving by permanent-split capacitor motor in which the electric contacts of the programmer for operating the motor intermittently according to the program, are connected to the middle terminals of first windings and second and third windings respectively of the stator windings, the second terminal of the first windings being connected to one terminal of a noise filter, while the second terminals of the other two windings are connected through a contact to the other terminal of the filter which, in turn, is connected to the supply system.

6. A circuit according to Claim 3 for driving by a reversible permanent split capacitor motor, in which the electric contacts of a programmer for operating the motor intermittently according to the program comprises two way switching contacts, the moving contact of which is connected to a terminal of a first windings, second terminal of the first windings being connected to a terminal of the noise filter, while the two terminals of second and third windings are separately connected to the fixed other terminals of the switching contacts, the common terminal of the second and third windings is connected to the other terminal of the noise filter which, in turn, is connected to the supply system.

7. A circuit substantially as hereinbefore described with reference to Fig. 1, Fig. 2 or Fig. 3 of the accompanying drawings.

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